10/540052

JC20 Rec'd PCT/PTO 2 2 JUN 2005

IMAGE CONTROL

The present invention relates to the field of hand-held
5 devices that are equipped with a processor and a digital
camera for capturing motion video or still images, in
particular such devices that further comprise a display
for displaying images or a graphical or character based
user interface.

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BACKGROUND ART

Hand-held devices provided with digital image capturing
equipment, digital processing power and high resolution
15 displays are becoming increasingly more common in a wide
variety of uses.

For example, small mobile phones are recently being
equipped with digital cameras and relatively small high
20 resolution LCD screens. Hand-held computers commonly
called "personal digital assistants" (PDA) are also
available and are typically equipped with small high
resolution display screens and have slots for receiving
e.g. a digital camera. Similarly, communicators having
25 both cellular communication and computer capabilities are
available, typically having small display screens and an
inbuilt or detachable digital camera. These small, hand-
held devices do not, and cannot, conveniently have
conventional input devices, such as a computer mouse and
30 other control keys. Therefore, conventional personal
computer interfaces, which also have their own drawbacks,
are not suited for these small hand-held devices.

As a result, there are significant limitations on using
35 such small hand-held devices in both obtaining output,
e.g. viewing data on the display screen, and in inputting

commands, e.g. changing the area viewed on the display screen or controlling the performance of a particular parameter associated with the device. Further, given the limited area available, not only on the display screen but also on the

5   entire device, adding additional control keys, etc., is both difficult and burdensome to a user requiring two hand operation of the device.

US 6466198 discloses a system and method for view navigation

10 and magnification of the display of hand-held devices in response to the orientation changes along only two axes of rotation as measured by sensors inside the devices. The view navigation system can be engaged and controlled by simultaneously pressing switches on both sides of the hand-

15 held device. Miniature sensors like accelerometers, tilt sensors, or magneto-resistive direction sensors sense the orientation changes. These miniature sensors are presently not typically standard equipment for hand-held devices. Thus, such sensors add cost, use precious space and add weight.

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The present invention is directed toward overcoming one or more of the above-identified problems.

DISCLOSURE OF THE INVENTION

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On this background, it is an object of the present invention to provide a hand-held device of the kind referred to initially, which allows user input with the same hand that holds the device, without requiring the dedicated sensatory

30 equipment used by prior art hand-held devices.

This object is achieved in accordance with claim 1, by providing a hand-held device comprising: a processor, a display, a digital camera for capturing motion video or still

35 images, means for presenting still images or motion video captured by said digital camera on said display; means for

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transforming a signal from the camera into a motion signal
indicative of the motion of the hand-held device; and <u>a user
interface in which motion of the hand-held device is - through
the motion signal derived thereof - used as a user input to
control operation of the hand-held device.</u>

Thus, by using a sensor that is available to start with in
many hand-held devices -- namely a digital camera -- for a
secondary use, namely creating a motion signal indicative of
the motion of the hand-held device, a hand-held device with
motion sensing is provided in a economical and reliable
manner.

The hand-held device may further comprise a user interface in
which motion of the hand-held device is - through the motion
signal derived thereof - used as a user input.

The hand-held may further comprise a display, preferably a
display suitable for displaying captured images.

Motion of a given type of the hand-held device can be used to
manipulate images shown at least in part on the display,
preferably by moving the images in a manner substantially
corresponding to the movement of the hand-held device.

Different types of motion the hand-held device can e.g. be
used to move, and/or zoom, and/or expand/collapse and/or
rotate images displayed on the display.

Motion substantially parallel to the plane of the display of
the hand-held device can be used to scroll an image displayed
on the display. Motion substantially perpendicular to the
plane of the display can be used to zoom an image displayed on
the display. Rotational motion of the hand-held device can be
used to rotate an image displayed on the display.

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The images that are manipulated can e.g. be images that were previously captured by the camera.

The movement of image can be inverted with respect to motion of the hand-held device, since some users may prefer this.

The user interface may comprise a graphical user interface and motion of the hand-held device can be used as an input to the graphical user interface.

Motion of the hand-held device can be used to manipulate an object displayed by the graphical user interface, preferably by moving the object in a manner substantially corresponding to the motion or to the inverted motion of the hand-held device, whereby the object displayed by the graphical user interface can be an icon, a dialogue box, a window, a menu or a pointer.

Motion of a given type of the hand-held device can be used to move, and/or zoom, and/or expand/collapse and/or rotate objects displayed by the graphical user interface.

Motion substantially parallel to the plane of the display of the hand-held device can be used to scroll an object displayed by the graphical user interface. Motion substantially perpendicular to the plane of the display can be used to zoom an object displayed by the graphical user interface. Rotational motion of the hand-held device can be used to rotate an object displayed by the graphical user interface.

The digital camera can be an inbuilt camera or can be a detachable camera. The camera may be movable relative to the hand-held device.

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The means for transforming a signal from the camera into a
motion signal preferably derives the motion signal from
changes between succeeding images captured by the camera.

5 The camera can be equipped with an autofocus system,
whereby the focusing setting of the autofocus system can
be used for detecting movement in the camera direction.

The hand-held device may further comprise at least one
10 key. The functionality of a motion type can be dependent
on the state of the at least one key.

Rotational motion of the hand-held device about an axis
substantially perpendicular to the display may be used to
15 cause an inverse rotational movement of the image or
graphical user interface object relative to the display,
preferably in a manner such that the image or object is
static with respect to the fixed coordinate system in
which the hand-held device is situated.
20

The motion signal can be used to adjust device settings,
such as sound settings, keypad settings and display
settings.

25 The hand-held device may further comprise a keypad with at
least a first and a second key and the graphical user
interface comprising a cursor, whereby motion of the hand-
held device can be used to position the cursor over an
object of the graphical user interface and primary
30 functions associated with the object concerned can be
activated by pressing the first key and secondary
functions associated with the object of the concerned can
be activated by pressing the second key.

35 The functionality of the first key can be associated with
selection and activation of objects of the graphical user

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interface, and the functionality of the second key can be associated with calling up a context-sensitive menu.

5 The selection of the object concerned can be performed by pressing and releasing the first key. Activation of the object concerned can be performed by pressing and releasing the first key twice in rapid succession. Moving or resizing of the object concerned can be performed by holding down the first

10 key while moving the hand-held device to move the cursor.

The first key and the second key can be softkeys, whereby the current functionality of the softkeys is shown in the display, preferably in dedicated fields of the display.

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The first key can be placed below the display on the left side of the latter, preferably proximate to lower edge of the display, and the second key can be placed below the display on the right side of the latter, preferably proximate to lower

20 edge of the display.

It is another object of the present invention to provide an improved method for proving user input to hand-held devices. This object is achieved by providing a method for creating

25 user input for a hand-held device that has a processor, a user interface and a digital camera for capturing motion video or still images comprising the steps of: <u>obtaining a camera signal, alternatingly using the camera signal</u> to <u>capture still images or motion video; or to</u> determine motion of the hand-

30 held device from the camera signal; and using the determined motion of the hand-held device as an input for the user interface.

It is yet another object of the present invention to provide a

35 use of a digital camera of a hand-held device

AMENDED SHEET

that has a processor to produce a motion signal indicative
of motion of the hand-held device.

A further object of the invention is to provide a hand-
5 held device with an improved graphical user interface.
This object is achieved by providing a hand-held device
comprising a processor, means for sensing motion of the
hand-held device, a display, a keypad with at least a
first- and a second key, a graphical user interface with
10 objects and a cursor, and means for transforming the
sensed motion of the handheld device into a signal
suitable for moving the cursor over the display.

By controlling the position of a cursor through motion of
15 the handheld device it becomes possible to provide a user-
friendly cursor controlled graphical user interface for
hand-held devices.

Preferably, motion of the hand-held device is used to
20 position the cursor over objects of the graphical user
interface and primary functions associated with the object
concerned are activated by pressing the first key and
secondary functions associated with the object concerned
are activated by pressing the second key.
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The functionality of the first key can be associated with
selection and activation of objects of the graphical user
interface, and the functionality of the second key can be
preferably associated with calling up a context-sensitive
30 menu.

Selection of the object concerned is preferably performed
by pressing and releasing the first key, and activation of
the object concerned is preferably performed by pressing
35 and releasing the first key twice in rapid succession.

Moving or resizing of the object concerned can be performed by holding down the first key while moving the hand-held device to move the cursor and the object concerned in unison therewith.

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The first key and the second key can be softkeys, whereby the current functionality of the softkeys is shown in the display, preferably in dedicated fields of the display.

10   The first key can be placed below the display on the left side of the latter, preferably proximate to lower edge of the display, and the second key can be placed below the display on the right side of the latter, preferably proximate to lower edge of the display.

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The means for transforming motion of the handheld device into a signal suitable for moving the cursor over the display may further comprise a tilt sensor and/or an image capturing device and/or an accelerometer.

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The hand-held device according may further comprise means to transform a signal from the image capturing device, i.e. camera and/or tilt sensor and/or accelerometer into a position signal for the cursor.

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The means for transforming a signal from the camera into a motion signal preferably derives the motion signal from changes between succeeding images, or parts of succeeding images captured by the camera.

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The camera may have an autofocus system, whereby the focusing setting of the autofocus system is used for detecting movement in the camera direction.

The graphical user interface may include one or more of the following object types: icons, dialogue boxes, windows, menus, pointers.

5   Further objects, features, advantages and properties of the hand-held device, method for proving user input and use of a digital camera in a hand-held device according to the invention will become apparent from the detailed description.

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BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present description, the invention will be explained in more
15   detail with reference to the exemplary embodiments shown in the drawings, in which:

Fig. 1 illustrates a preferred embodiment of a hand-held device according to the invention,
20   Fig. 2 shows a block diagram of the hand-held device of the embodiment of Fig. 1,
Fig. 3 indicates the axes of movement and rotation along which the hand-held device is moved and rotated in order to create user input in accordance with the present
25   invention,
Figs. 3.1 to 3.7 illustrate the use of the present invention for zooming, scrolling and rotating images shown on the display,
Figs. 3.8 to 3.10 illustrate the use of the present
30   invention for user input to a graphical user interface to scroll a table in a window and to resize a window,
Figs. 3.11 to 3.13 illustrate the use of the present invention for scrolling a magnifying window over the display,

Figs. 3.14 and 3.15 illustrate the use of the present invention for moving a part of an image by cutting an pasting,

Fig. 3.16 illustrates the use of the present invention with a text editing application,

Fig. 3.17 illustrates the use of the present invention with an application for entering musical notes in a stave,

Fig. 3.18 illustrates the use of the present invention with a labyrinth game

Fig. 3.19 illustrates the use of the present invention for controlling a video game,

Fig. 3.20 illustrates the use of the present invention with an application for controlling the sound settings of a music player funtion,

Fig. 4 outlines a software flow diagram for zooming, scrolling and rotating images shown on the display, and

Figs. 5 and 6 show an alternative preferred embodiment of a hand-held device according to the invention.

DETAILED DESCRIPTION

This invention allows hand-held communication or computing devices with a relatively small display to receive user input by moving or rotating the device. In particular with devices having a display, the invention allows convenient navigation of a large stored virtual display or of objects in a graphical user interface. Such devices may include PDA devices, camcorders, digital photo cameras, digital binoculars (solid-state stereoscopic imaging system incorporated for viewing and digitally recording magnified stereo images), mobile hand-held terminals, advanced pagers, mobile telephones, and communicators.

According to a preferred embodiment, the hand-held device is a hand portable phone, preferably a cellular/mobile phone.

Fig. 1 shows a mobile phone according to the invention, and it will be seen that the phone, which is generally designated by 1, comprises a user interface having a

5   keypad 2, a display 3, an on/off button 4 , a speaker 5 (only the openings are shown), and a microphone 6 (only the opening is shown). The phone 1 according to the preferred embodiment is adapted for communication via a cellular network, such as the GSM 900/1800 MHz network.

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The keypad 7 has a first group of keys 8 as alphanumeric keys, by means of which the user can enter a telephone number, write a text message (SMS), write a name (associated with the phone number), etc. Each of the

15 twelve alphanumeric keys 8 is provided with a figure "0-9" or a sign "#" or "*", respectively. In alpha mode each key is associated with a number of letters and special signs used in the text editing.

20 The keypad 7 additionally comprises two softkeys 9, two call handling keys 12, and an arrow key 10. The function of the softkeys depends on the state of the phone and the navigation in the menu can be performed by using the navigation-key. The present function of the softkeys 9 is

25 shown in separate fields in the display 3, just above keys 9. The two call handling keys 12 are used for establishing a call or a conference call, terminating a call or rejecting an incoming call. This key layout is characteristic for e.g. the Nokia 6210™ phone.

30

The arrow key 10 is an up/down key which can be used for cursor movement and scrolling and is placed centrally on the front surface of the phone between the display 3 and the group of alphanumeric keys 7. A battery pack 14 is

35 mounted on the back of the phone and supplies electrical power for the electronic components of the mobile phone.

The phone has a flat display 3 that is typically made of a
LCD with optional back lighting, such as a TFT matrix
capable of displaying color images.

5

The phone is equipped with a digital camera 35 of which
only the lens 36 is visible in Fig. 1. The camera is
arranged at the rear of the phone above the battery pack
14. The camera direction is therefore substantially
10 perpendicular to the rear surface of the phone 1. Just
under the camera an infrared port 38 for IrDA
communication is provided (only window of the port is
shown). The camera may alternatively have a rotatable
connection to the phone (not shown), to allow adjustment
15 of the camera direction relative to the housing of the
phone.

Fig. 2 schematically shows the most important parts of a
preferred embodiment of the phone, in the form of a block
20 diagram. A processor 18 controls the communication with
the network via the transmitter/receiver circuit 19 and an
internal antenna 20. A microphone 6 transforms the user's
speech into analogue signals, the analogue signals formed
thereby are A/D converted in an A/D converter (not shown)
25 before the speech is encoded in a digital signal
processing unit 14 (DSP). The encoded speech signal is
transferred to the processor 18, which i.e. supports the
GSM terminal software. The processor 18 also forms the
interface to the peripheral units of the apparatus,
30 including a RAM memory 17a and a Flash ROM memory 17b, a
SIM card 16, and the keypad 2 (as well as data, power
supply, etc.). The digital signal-processing unit 14
speech-decodes the signal, which is transferred from the
processor 18 to the earpiece 5 via a D/A converter (not
35 shown). The processor communicates in two directions with
the IrDA port 38 (infrared port) that allows data

communication with other devices that are equipped with
such a port, such a PC's, laptops, personal digital
assistants (PDA) and other mobile phones. The phone may
further be equipped with a short range RF transmitter
5   receiver (not shown), e.g. according to the Bluetooth
standard, for data transmission with other devices as
mentioned for IR data communication.

The processor 18 also forms the interface for the display
10   controller 31. The image controller 31 receives the image
files from the processor 18 and renders images for showing
on the display 3.

A camera controller 37 is also connected to the processor
15   18 and controls the digital camera 35. The camera
controller 37 sets the resolution, the refresh rate, the
focus, and zoom factor of the camera 35. The camera
controller 37 sets the focus automatically through any of
the well-known auto focus techniques available. The output
20   signal of the camera 35 is connected to the processor 18.

When the camera is used to detect motion of the hand-held
device, the camera controller 37 automatically selects the
appropriate resolution and refresh rate, so that the
25   refresh rate is high enough to derive a smooth motion
signal from the changes in the succeeding images. For
motion detection it is not usually necessary to use the
complete image captured by the digital camera. The
software can pick out a particular section of the image
30   for the motion detection so that the amount of data that
has to be processed is reduced. These two measures (low
resolution and using a section of the image) allow higher
sampling rates and reduced power consumption because of
lower data processing power demands.

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Some surfaces in the camera view may not be particularly
suited for detecting motion, e.g. because of a uniform
surface, or because the distance to the objects in the
camera view is too large to determine changes in distance
5   accurately. Such problems may be solved (in the embodiment
with the adjustable camera direction) by directing the
camera to another available object with sufficient
texture, such as the user. The camera direction is thus
reversed compared to the "normal" direction. The motion
10   signal derived from the camera signal is therefore
automatically inversed when the camera is directed to the
user.

The camera 35 is a conventional digital camera and
15   therefore not all the features of the camera 35 are shown.
The image sensor of the digital camera can be any of the
known configurations for solid-state image sensors, such
as frame transfer, interline transfer CCDs, or diode
arrays.
20

Standard CCD devices are sensitive to both visual light
and near infrared light. Conventional digital cameras for
capturing images with visual light are therefore provided
with an infrared filter for preventing influences of
25   infrared light on the captured image. The mobile phone 1
is also provided with an infrared filter (not shown). The
infrared filter can be moved out of the path of the light
into the camera for capturing infrared images. The IrDA
port 38 can be set to irradiate continuously to function
30   as a light source for the camera 35 when it is in the
infrared mode. Thus, the camera 35 can be used when there
is little or no ambient light. The use of an IrDA port as
a light source for a digital camera and the details of a
device to move the infrared filter in and out of the
35   camera path as well adjustments to the auto focus system

are disclosed in US patent application with serial nr.
10/029,968, hereby incorporated by reference.

5   The lens 36 is preferably a fixed focal length lens with
movable lens group to allow auto focus, however, lens 36
could be any type of lens providing for adjustment to
focus on different parts of the image received, as will be
understood to those skilled in the art.

10   The characteristics of visible light and near infrared
light with respect to focusing are slightly different.
Therefore, the auto focus system has two settings; a first
setting for capturing images with visual light and a
second setting for infrared light.

15

Standard software for processing, storing and recalling
pictures captured with visual light and captured with
infrared light is installed on the phone 1. This software
may as such be conventional and commercially available.
20   The software is also able to control the refresh rate of
the images shown on the display.

Optionally, the phone 1 may also comprise one or two tilt
sensors 39 which determine the direction and magnitude of
25   the displacement relative to vertical using the planetary
gravitational field. Such sensors could be any of well
known types such as those operating with an encoding disk
on a freely rotatable shaft connected to a weight, or of
the type that uses sphere provided with an asymmetrical
30   weight that floats in a liquid. Alternatively the tilt
sensor could by of the gyroscopic type. The signals of the
camera the tilt sensors can be combined for generating the
motion signal.

35   The phone 1 in accordance with e preferred embodiment
employs two operational modes associated with the use of

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motion of the phone to generate user input, which
throughout this document are referred to as navigation
mode and fixed mode. When set to the navigation mode,
motion of the phone 1 is used as input, and when
5   displaying an image, the display view is automatically
scrolled, zoomed and rotated to follow movements of the
holding hand. The navigation mode is activated by pressing
the left softkey 9 "Navigate". Thus, the navigation mode
is activated and the functionality of the left softkey 9
10 changes to "Fixed". When set back to the fixed mode by
pressing the left softkey "Fixed" again, the display view
becomes stationary and no longer follows the movements of
the hand.

15 Fig. 3 indicates the relative axes of orientation along
which the phone 1 is rotated or translated in order to
navigate an image on the display 3. Throughout this
document, axis 40 will be referred to as the Y-axis, and
motion of the phone in the direction of the Y-axis is in a
20 preferred embodiment used to scroll images in the Y-
direction. Similarly, axis 41 will be referred to as the
X-axis and motion of the phone in the direction of the X-
axis is in a preferred embodiment used to scroll images in
the X-direction. Motion in the camera direction measured
25 along the Z-axis 42 is in a preferred embodiment used to
control the zoom factor of the images shown on the display
3. Rotation about the Z-axis is used to rotate images
shown on the display 3. Though these are the preferred
functions assigned with movements along the X- ,Y- and Z-
30 axes, any other functionality can be assigned to movement
in the direction of these axes or to rotational movement
about these axes.

While the scrolling, zooming, and rotation of the display
35 follows the movements of the device, the rate of
scrolling/zooming/rotation as well as the amount of

scrolling/zooming/rotation need not follow the exact
amount of change in position, and can be inverted. As will
be discussed below, the control software of the present
invention can smooth the movements of the phone to provide
5 a convenient effect on the display.

Figs. 3.1 to 3.13 show an overview of the operation of the
phone 1 to scroll, zoom and rotate images.

10 With reference to Fig. 3.1, a high resolution image of a
holiday snapshot comprising a lake, a bridge and a
mountain peak stored in the RAM 17a is shown for viewing
on the display 3. The display 3 is too small to show the
entire image with sufficient size to appreciate all the
15 details in the image conveniently. The user presses the
left softkey 9 "Navigate" to enter the navigation mode.
The phone activates the navigation mode and changes the
label above the left softkey 9 to "Fixed". In Fig. 3.2,
the navigation process is started when the operator's hand
20 moves the phone 1 along the Z- axis 42 in the direction of
arrow 42' for magnifying the view so that the display 3
shows the central portion of the image with the bridge in
an enlarged manner (Fig. 3.3). By moving the phone along
the Y-axis 40 in the direction of arrow 40' the display 3
25 scrolls the images upwards and the mountain peak above the
bridge can be viewed (Fig. 3.5).

In Fig. 3.6 the holiday snapshot is shown in a portrait
orientation and can only be properly viewed with the phone
30 in a horizontal position. The user wishes to view the
image with the phone in an upright position so that the
image will be displayed in a landscape position with
respect to the display 3. The user presses the left
softkey 9 "Navigate" to activate the navigation mode and
35 rotates the phone a half turn anticlockwise (Fig. 3.7).
The movement of the phone 1 creates a series of changing

images captured by the camera 35 from which the software
on the phone derives a motion signal. Upon detection the
rotational movement about the Z-axis the software on the
phone rotates the displayed image in the opposite
5   direction, and when the user has completed a half
anticlockwise turn the software has rotated the image a
half turn clockwise, and the user can conveniently view
the image with the phone in an upright position. The image
is thus static with respect to the fixed coordinate system
10   in which the phone 1 device is situated.

The settings for the responses to motion of the phone 1
can thus be set in way in which the user perceives the
view as that of a static image over which a magnifying
15   window (the display 3) is moved.

Fig. 3.8 shows a display 3 of the phone in a mode in which
a graphical user interface is used to command the device.
A window 70 containing a scrollable table is displayed on
20   the display 3. Scroll bars 71 and 72 are shown to the
right and at the bottom of the table, respectively. A
cursor 73 can be moved over the display by moving the
phone in the direction of the X- and Y-axes. The left
softkey 9 "Left-click" has the same functionality as the
25   left mouse button as known from many windows based
graphical user interfaces, namely to select a primary
function associated with an object marked by the cursor
73. By clicking, double clicking or holding the left
softkey 9 down. The right softkey 9 "Right-click" also has
30   the same functionality as the right mouse button as known
from many windows based graphical user interfaces, namely
to select secondary functions associated with an object
marked by the cursor 73. It is possible to assign the
"Left click" and "Right click" to other keys of the phone,
35   but using a similar layout as for the keys of a computer
mouse may facilitate user acceptance.

Example 1: The user wishes to scroll the table to the
right to view column E. By holding the left softkey 9
"Left-click" pressed and moving the phone to the right
5   along the X-axis the table is scrolled by dragging it with
the cursor to the right as shown in Fig. 3.9.

Example 2: The user wishes to resize the window 70. After
placing the cursor 73 on the upper bar of the window 70
10   and while holding the left softkey 9 "Left-click" movement
of the phone 1 in the direction of the Z-axis resizes the
window 70. Moving the phone towards the user enlarges the
window as shown in Fig. 3.10 and moving away from the user
reduces the size of the window (not shown).

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Example 3: The user wishes to move a part of an image in
an image editing program. The part of the image to be
moved is marked with a sizable box 65. Holding the left
softkey 9 "Left-click" down and moving the mouse by
20   rotating the phone about the X- and Y-axis resizes the box
(Fig. 3.14). After sizing the box 65 the left softkey 9 is
released and the cursor 73 can be moved freely. The box
can be dragged and dropped to the desired position by
placing the cursor 71 in the box 65 and holding the left
25   softkey 9 "Left-click" down whilst rotating the phone
about the Y- and/or X-axis until the box has moved to the
desired position. By releasing the left softkey 9 the
boxed is dropped and the cursor 73 can move freely again.
Thus, the part of the image in the box is cut from the
30   original position and pasted to the new position.

In the same or manner any object e.g. text in a text
editor program, or numbers/text in a spreadsheet can be
marked, resized, dragged and dropped "click and drag" with
35   the left softkey.

The most common "gestures" performed by moving the phone
and pressing the softkeys are:

- point (to place the cursor over an object of the
  graphical user interface),

5   - left-click (to press and release the left softkey)
     to select the object which the cursor is placed,

- double-click (to press and release a softkey twice
  in rapid succession) to activate the object that the
  cursor is placed over,

10   - right-click (to press and release the right softkey)
     to call up a context-sensitive menu, and

- drag (to hold down the left softkey while moving the
  phone to move the cursor) to move or resize objects.

15   Figs. 3.11 to 3.13 show another method of manipulation
magnified portion of an image. Fig. 3.11 shows the display
3 with an image of a several advanced type mobile phones.
A magnifying window 103 enlarges a portion of the image to
allow the user a view with both a good overview and the
20   possibility to view detail in a selected portion of the
image. The magnifying window 103 can be moved over the
display 3 by holding down the left softkey 9 "Navigate"
whilst moving the phone in the direction of arrow 41'
and/or arrow 40' (Fig. 3.12) to place the magnifying
25   window at the desired position (Fig 3.13). The magnifying
factor of the magnifying window can be changed by moving
the phone 1 in the direction of the Z-axis (not shown).

Fig 3.16 shows another example of the use of the present
30   intention in the form of an application for entering text.
In the upper part of the display shows a string of
characters already entered. A set of characters that can
be entered, in this example the alphabet, is displayed
below the upper part of the display. Other character sets
35   could comprise a number set or special signs set, etc.

The functionality of the left softkey 9 "Type" and the right softkey 9 "Options" is shown in the lower part of the display. One of the characters of the character set is marked by bold print. By rotating the phone about the Y-axis 40 the marking moves left or right. By rotating the phone about the X-axis 41 the marking moves up and down. The marked character is added to the string of characters by pressing the left softkey 9 "Type".

By pressing the right softkey "Options" a scrollable list of selectable menu items is displayed (not shown) comprising: "Clear last character", "Clear screen", "Number character set", "Symbol character set", and "Exit", one of the menu items being marked by inverse print. The list can be scrolled by rotating the phone about the Z-axis 41, and the marked menu item is selected by pressing the left softkey 9 "Select".

Fig 3.17 shows another example of the use of the present invention in the form of an application for entering musical notes in a stave 69. A cursor 73 (shape changed to a cross for this application) is used to indicate the position where a note is to be entered. By rotating the phone about the Y-axis 40 the cursor can be moved left an right. By rotating the phone about the X-axis 41 the cursor can move up and down.

The cursor is placed above the position in the stave at which a note is to be entered, higher tones are placed higher up in the stave and lower tones are placed lower in the stave. A tone is entered by pressing the left softkey 9 "Type". After typing a note the application prompts for entering the length of the note by displaying the text "Length? 1=1 2=½ 4=¼ 8=$^{1}/_{8}$" between the stave and the labels for the softkeys. The note length is entered by

pressing the alphanumeric key with the value associated
with the desired note length.

By pressing the right softkey "Options" a scrollable list
5   of selectable menu items is displayed (not shown)
comprising: "Clear last note", "Clear stave", "Enter
special notes", and "Exit", one of the menu items being
marked by inverse print. The list can be scrolled by
rotating the phone about the X-axis 41, and the marked
10   menu item is selected by pressing the left softkey 9
"Select".

Fig. 3.18 shows another example of the use of the present
invention in the form of an application simulating a
15   labyrinth game. The player (user of the hand-held device)
endeavors to guide a virtual ball 59 through a virtual
labyrinth formed by virtual walls 57 on a virtual playing
surface past a plurality of virtual openings 58 though
which the virtual ball 59 may drop.
20

The application simulates the effect caused by gravity
that tilting a real playing surface out of the horizontal
plane has on a real ball, e.g. the virtual ball starts
rolling to the lower side of the display 3 when the latter
25   is tilted out of the horizontal plane. Also the effect of
gravity on a real ball passing over a real opening is
simulated by the application, e.g. the virtual ball drops
through the virtual opening when it passes over a virtual
opening.
30

At the start of the game, the display is held
horizontally, or any other orientation that the user deems
suitable as reference orientation to calibrate the virtual
"horizontal" position of the display. The movement of the
35   virtual ball over the virtual playing surface is
controlled by moving the phone out of- and back into the

horizontal plane by rotating it rotating about the Y-axis
40 and/or the X-axis. The rotational movements are
detected from the changes between the succeeding images
captured by the camera and translated into changes in
5   speed and rolling direction of the virtual ball.

Fig 3.19 shows another example of the use of the present
invention in the form of an application for controlling
another computer game, in this example a car racing
10   simulation. The player (user of the hand-held device)
endeavors to "drive" a car around a racing circuit as fast
as possible. The application allows the player to control
the steering breaking and giving gas functions. The
imaginary view on the racing circuit is the main content
15   of the display, but is not shown on Fig. 3.19. The display
further shows a steering wheel and rearview mirrors. A
race is started by double clicking the left softkey 9
"Action". The control settings for speed and directions
are calibrated and set to zero for the present position
20   and orientation of the phone 1. After an audible start
signal the driver is supposed to attempt to follow the
displayed racing circuit. The "car" is steered by rotating
the phone about the z-axis 42. Rotating the phone
clockwise out of the calibrated position about the Z-axis
25   makes the "car" turn right. Rotating the phone further out
of the calibrated orientation, make the "car" turn sharper
and vice versa. Similarly, rotating the phone anti-
clockwise about the Z-axis out of the calibrated position
makes the "car" turn left. The speed of the "car" is
30   controlled by tilting the phone 1 about the X-axis 41.
Rotating the phone 1 out of the calibrated position in one
direction is used to give "gas". Rotating the phone 1
further out of the calibrated orientation increases the
amount of "gas", and vice versa. The amount of breaking
35   applied to the car is similarly controlled by rotating the
phone 1 out of the calibrated position in the opposite

direction. The user may select which direction of rotation about the X-axis is used to give "gas", whereby the breaking direction is always the opposite. Other computer games that can be controlled in a similar manner but using

5 more axes of motion/control include motor bike racing, and helicopter flying. For motorbike racing the factor balance can be included in relation to motion about one of the axes, to produce a very realistic experience, with e.g. steering bar rotation connected to rotation about the Z-

10 axis, giving gas and breaking connected to rotation about the X-axis and balance connected to translative motion along the X-axis. For enhancing the games the capacity of the mobile phone to generate sound via the loudspeaker, in particular a hands-free loudspeaker is used to simulate

15 e.g. motor, and/or propeller sound. The vibrator function (not shown) of the mobile phone can be used to give feedback in connection with shocks and crashes.

Fig 3.20 shows another example of the use of the present

20 invention in the form of an application for controlling the sound setting of a music player function of the phone. The application allows a user to control volume, bass and treble. The application shows a volume button, a bass button and a treble button on the display 3. The button

25 that is to be manipulated is be marked by a higher line thickness (as shown for the "Volume" button in Fig. 3.20). The marking can be moved to other buttons by rotating the phone about the Y-axis 40. The marked button is manipulated by holding the left softkey 9 "Control" down

30 while rotating the phone about the Z-axis 42. Clockwise rotation of the phone results in an increased setting of the parameter concerned, anticlockwise rotation of the phone results in a decreased setting of the parameter concerned. The application ends by pressing the right

35 softkey 9 "Exit". Alternatively, the display shows slide control knobs for each of the parameters to be controlled

(not shown). The knob that is to be manipulated is be
marked by a higher line thickness. The marking can be
moved to other knobs by rotating the phone about the Y-
axis 40. The marked knob is manipulated by holding the
5   left softkey 9 "Control" down while moving the phone in
the direction of the Z-axis 42. Moving the phone in the
direction in which the display 3 is facing increases the
parameter setting concerned, moving the phone in the
opposite direction results in a decreased setting of the
10   parameter concerned.

Another example of the use of the present invention is in
connection with another terminal such as a PC (not shown).
The motion signal of the phone is transmitted to the PC to
15   control the movement of an object. The object could be a
3-D object displayed on a screen connected to the PC,
whereby orientation changes of the phone are used to
change the orientation of the displayed object. The
orientation of the object on the screen can be completely
20   synchronized with the orientation of the phone. After an
initial calibration of the relative positions, e.g. when
the phone is upright, the displayed object is also
upright. For e.g. presenting a product, the product can be
shown as an object on a large screen. To change the
25   orientation of the object the user changes the orientation
of the phone by rotating it, and the PC rotates the
displayed object in the same way in response to the signal
that it receives from the phone.

30   Another example of using the phone with another terminal,
i.e. a workstation or a PC is for moving through an
imaginary 3-D space displayed on a screen by e.g. a CAD
program. The movements of the phone in the real 3-D world
are incorporated in the signal that is sent to the
35   workstation and the PC or workstation translates the
signal to movements of the viewing position in the "3-D

space" displayed on the screen. Changes in the orientation
of the phone are also incorporated in the signal that is
sent to the workstation and translated to changes of the
viewing direction in the "3-D space" displayed on the
5   screen. Thus the user can "walk" through an imaginary room
by walking around in the real world whilst holding or
carrying the phone, and change the viewing direction by
pointing the phone in the desired viewing direction. To
facilitate this manner of use, the invention could be
10   incorporated in a smaller device that is integrated in a
helmet or mounted to another kind of headgear, so that
viewing direction can be changed by the user turning
his/her head in the desired direction of view.

15   This manner of controlling the viewing position and the
viewing direction can equally well be used for computer
games and any other software applications that display a
virtual 3-D space on a screen, i.e. to move through and
observe a room, or any other place created in a virtual
20   world. Another example of a use of this manner of
controlling is game application that guides, i.e.
instructs a user to follow a virtual path and checks
through the motion signal if the user really travels this
path. Such games could be used by a group of users with
25   interactive mobile phones in a suitable open space such as
a sports ground.

Fig. 4 outlines the software flow diagram for the
manipulation of an image as described with reference to
30   Figs. 3.1 to 3.7. The flow from start 80 to end 98 is
performed several times a second in a standard polling
process of the processor 18. At the initialization step at
block 82, the current view settings are marked. The label
above the left softkey 9 is set to "Navigation" in block
35   84. The status of the left softkey 9 is checked in block
86. If the left softkey 9 is pressed, the system is set to

the navigation mode in block 88 and the label above the
left softkey is changed to "Fixed".

At block 90 the camera image and auto focus settings are
5   acquired, stored and compared to the previous readings. If
a change in image or in auto focus setting is detected at
block 92, the program derives the movement of the phone 1
from the changes in block 94 and computes the new view
settings i.e. zoom factor, rotation angle and portion of
10   the image to be displayed. It also instructs the display
controller 31 to refresh the display 3 to show the new
view and it saves the present camera image as the basis
for comparison in the next iteration of the process.

15   In block 96 the status of the left softkey 9 is checked
and if it is pressed the process ends at block 98 until
the program is polled again. If the check for the left
softkey 9 is negative, the program goes to step 90 and the
above process repeats itself.
20

The program can be set with different response curves for
computing the new view setting in response to changes in
camera image and/or auto focus setting at block 94. Fine
or coarse modes of response can be set by the operator or
25   can be changed dynamically during the time the system is
in the navigation mode. With fine response, the display
view changes at a relatively slow rate in response to the
movements of the phone. With coarse response, the display
view changes rapidly in response to the movements of the
30   phone. The response can also be inverted to adapt to user
preferences.

The functionality associated with a given type of motion
of the phone 1 can be set. Thus, the user can e.g. set the
35   program such that the cursor 73 can be moved up and down
by rotation about the X- axis and can be moved left and

right by rotation about the Z-axis. Given types of motion
of the phone 1 can be associated with functionality that
does not relate to the display 3, such as sound settings
(e.g. volume and balance) and display settings (e.g.
5   brightness, color balance and contrast).

Figs. 5 and 6 show an alternative preferred embodiment of
a hand-held device according to the invention in the form
of a communicator 101. The communicator 101 is basically
10 built up in the same way as the mobile phone 1 though with
a larger display 103 and a larger keyboard 107. A camera
135 (only lens 136 is shown) is mounted in the back/bottom
of the communicator and has the same functionality as the
camera in the phone 1. The internal hardware is also build
15 up in the same way as the phone 1, but with increased
processing power and a larger memory. Movements of the
communicator 101 in the direction of or about the X-axis
141, the Y-axis 140 and Z-axis 142 have the same
functionality as in the phone 1.
20

Although the present invention has been described in
detail for purpose of illustration, it is understood that
such detail is solely for that purpose, and variations can
25 be made therein by those skilled in the art without
departing from the scope of the invention.

Thus, while the preferred embodiments of the devices and
methods have been described in reference to the
30 environment in which they were developed, they are merely
illustrative of the principles of the inventions. Other
embodiments and configurations may be devised without
departing from the scope of the appended claims.